Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
          SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 1 of 21

ADDRESS TENURE

| ARBITRATION | TRANSFER | TERMINATION |

INDEPENDENT ADDRESS AND DATA

DATA TENURE

| ARBITRATION | SINGLE-BEAT TRANSFER | TERMINATION |

FIG. 1

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 2 of 21

FIG. 2

Express Mail No. EV342133814US
Title: Bus Transaction Reordering in a Computer
System Having Unordered Slaves
Inventor: James D. Kelly et al.
Atty. Docket No.: 18602-08098
Sheet 3 of 21
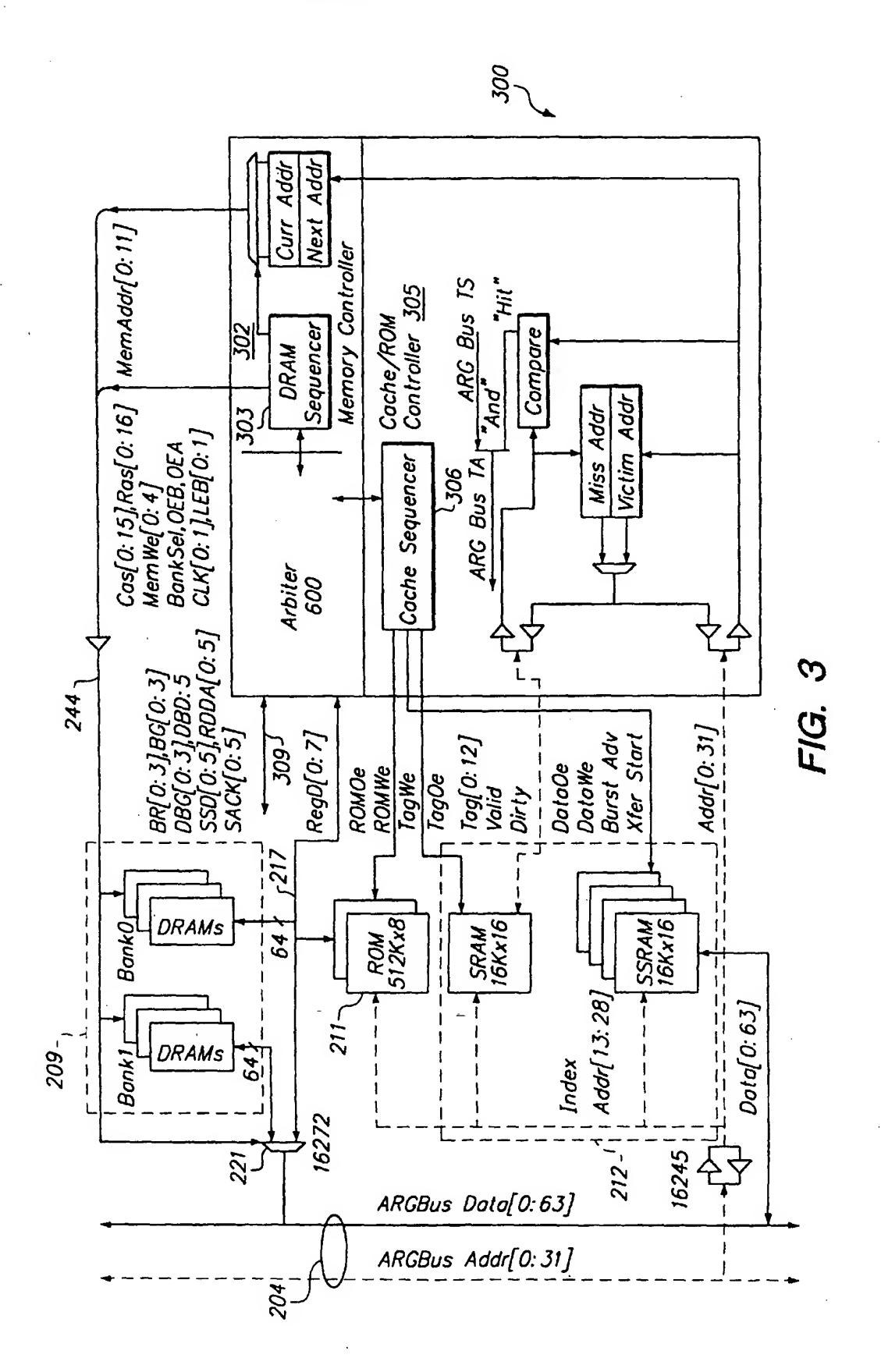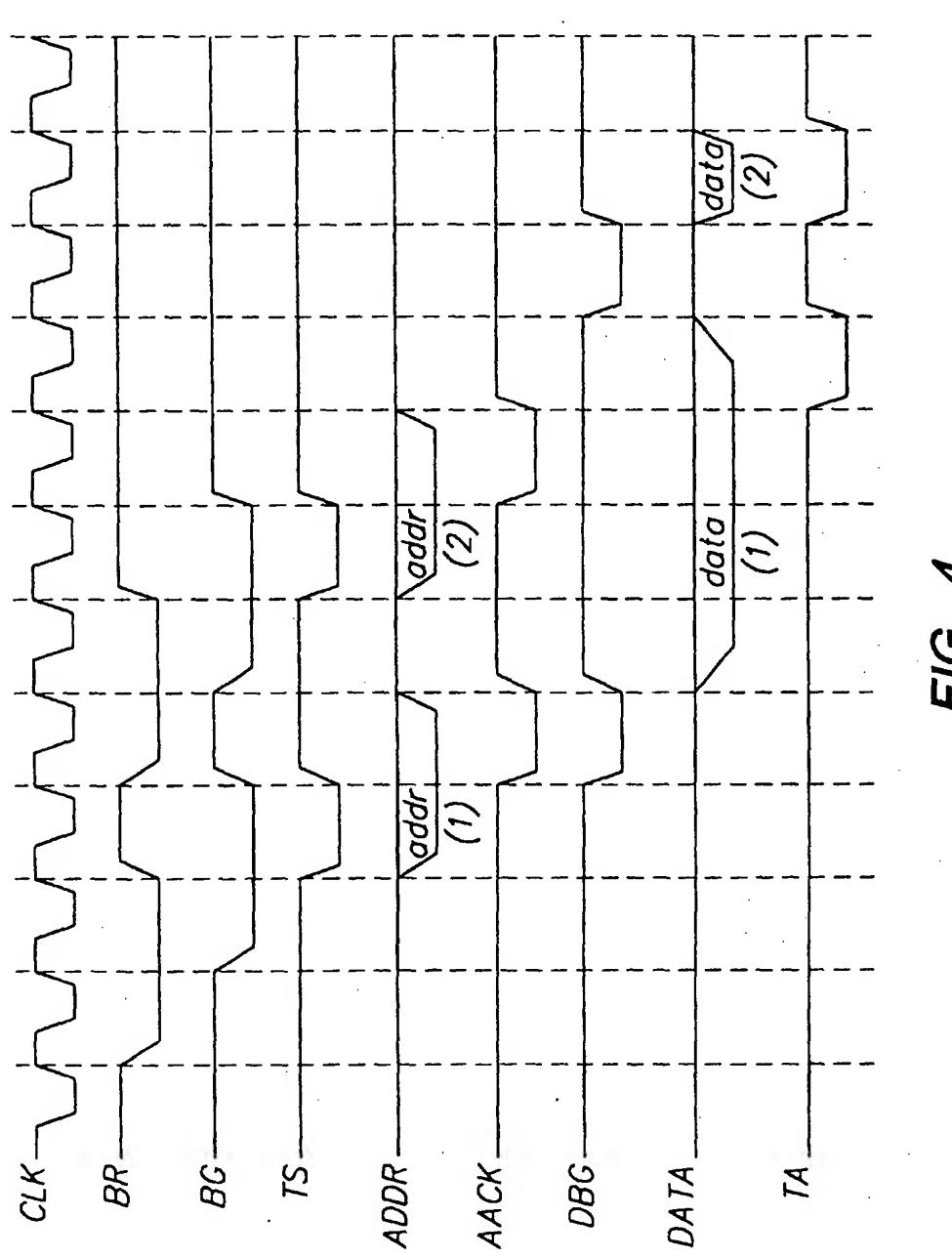
FIG. 3

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
          SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 4 of 21

CLK

BR

BG

TS

ADDR   addr (1)   addr (2)

AACK

DBG

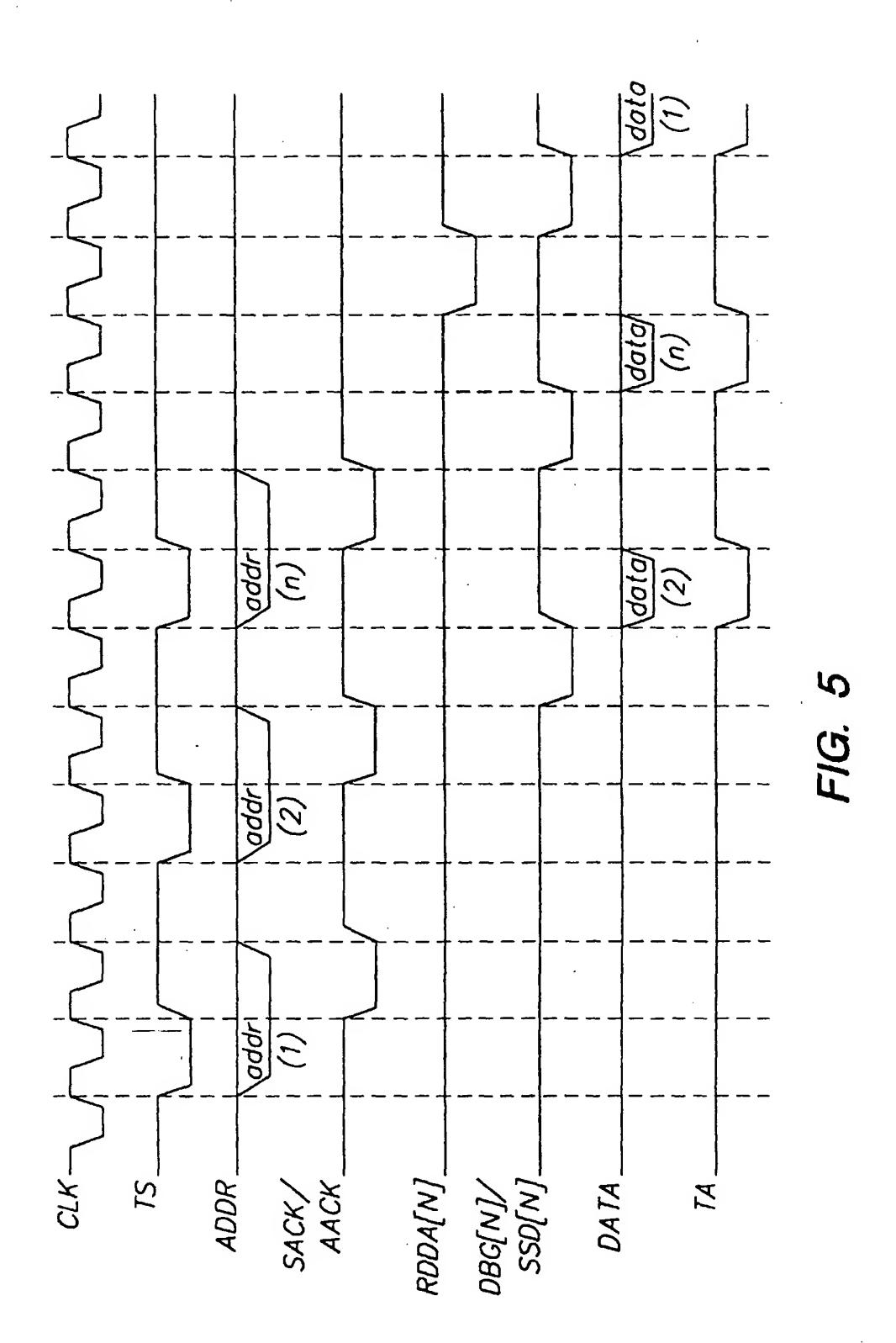DATA   data (1)   data (2)

TA

FIG. 4

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
         SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 5 of 21

FIG. 5

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 6 of 21

FIG. 6

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
        SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 7 of 21

FIG. 7

FIG. 7A
FIG. 7B

FIG. 7A

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
          SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
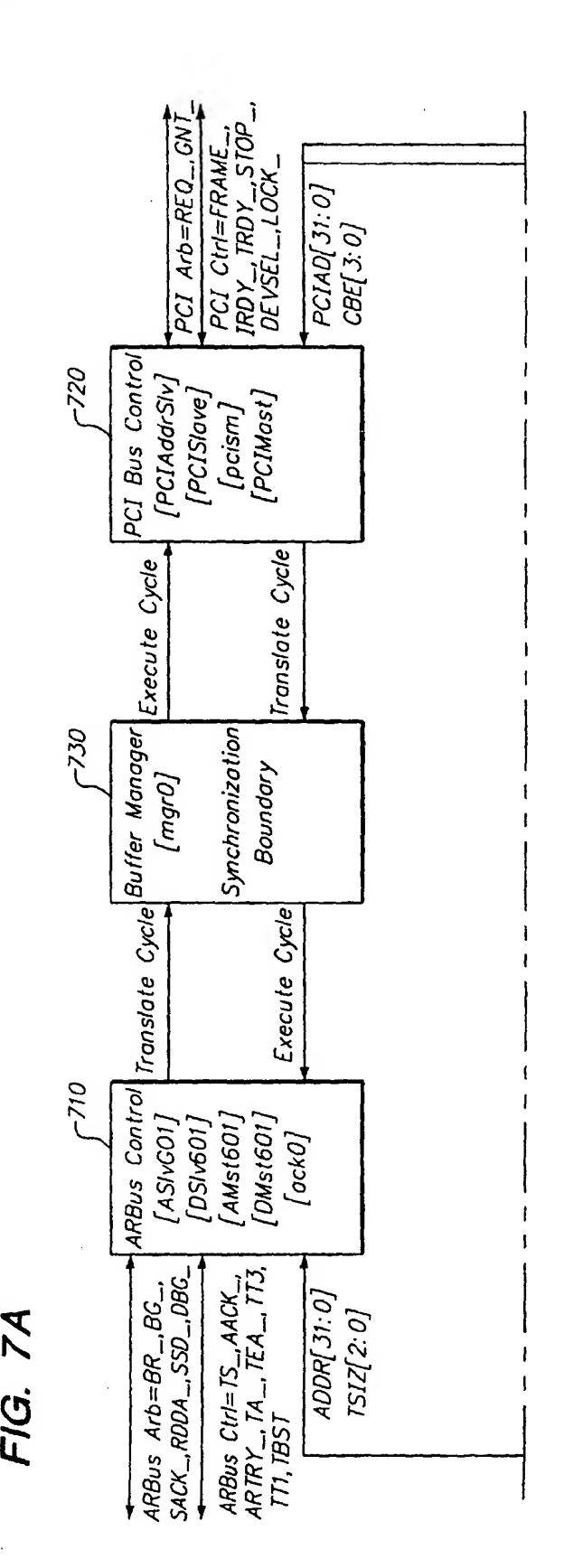Sheet 8 of 21

CBE[3:0]   PCIAD[31:0]

| Control Regs | Control Regs | 32-bit Register | 32-bit Register |

PCIBus Master Buffers

Address Swizzling

[dbuf3]

Data[31:00]_CachePos3
Data[63:32]_CachePos3
Data[31:00]_CachePos2
Data[63:32]_CachePos2
Data[31:00]_CachePos1
Data[63:32]_CachePos1
Data[31:00]_CachePos0
Data[63:32]_CachePos0
Address[31:0],R/W_Size,Bst

[dbuf1]

Address[31:0],R/W_Size,Bst
Data[63:32]_CachePos0
Data[31:00]_CachePos0
Data[63:32]_CachePos1
Data[31:00]_CachePos1
Data[63:32]_CachePos2
Data[31:00]_CachePos2
Data[63:32]_CachePos3
Data[31:00]_CachePos3

[dbuf2]

Data[31:00]_CachePos3
Data[63:32]_CachePos3
Data[31:00]_CachePos2
Data[63:32]_CachePos2
Data[31:00]_CachePos1
Data[63:32]_CachePos1
Data[31:00]_CachePos0
Data[63:32]_CachePos0
Address[31:0],R/W_Size,Bst

[dbuf0]

Address[31:0],R/W_Size,Bst
Data[63:32]_CachePos0
Data[31:00]_CachePos0
Data[63:32]_CachePos1
Data[31:00]_CachePos1
Data[63:32]_CachePos2
Data[31:00]_CachePos2
Data[63:32]_CachePos3
Data[31:00]_CachePos3

Byte Swapping

Address Swizzling
Byte Swapping

ARBus Master Buffers

| 32-bit Register | 64-bit Register | 64-bit Register |

ADDR[31:0]   DATA[63:0]
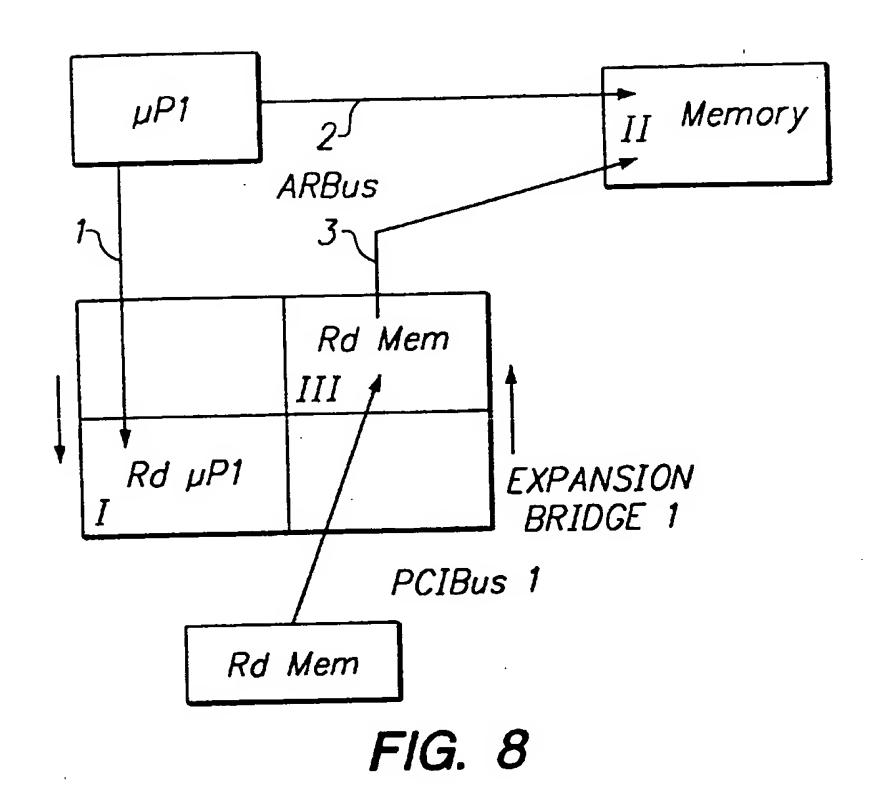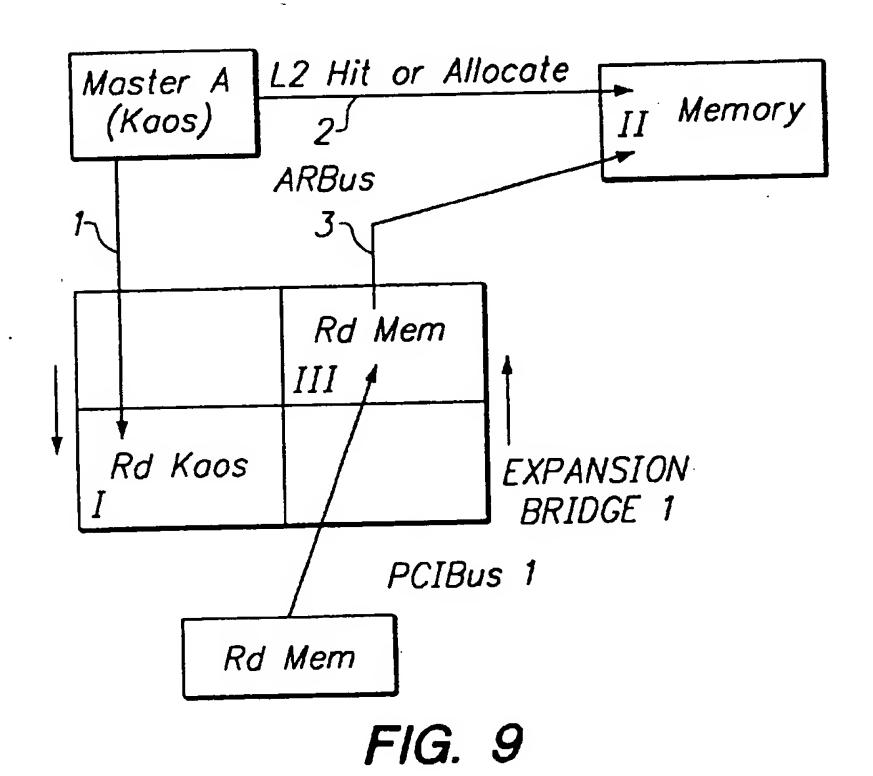
FIG. 7B

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
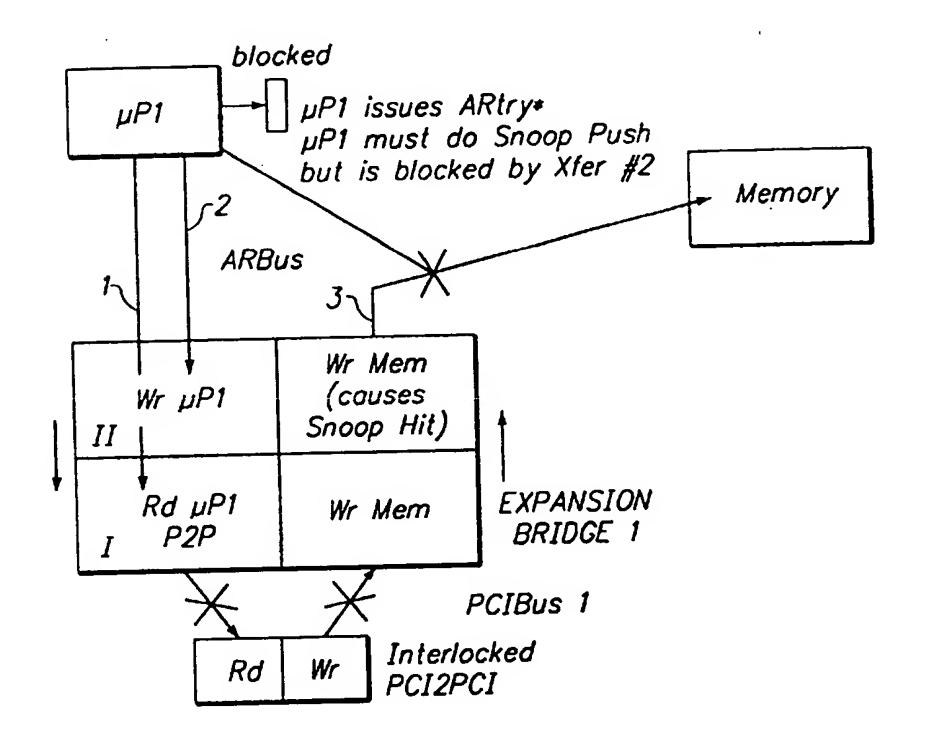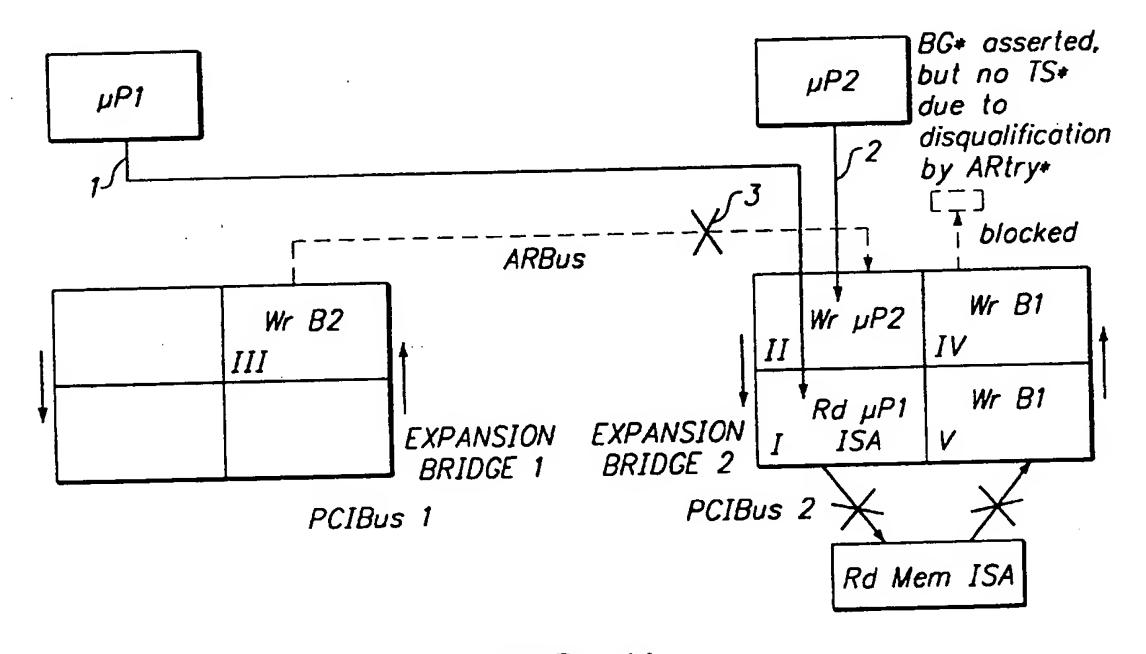Atty. Docket No.: 18602-08098
Sheet 9 of 21

FIG. 8

FIG. 9

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
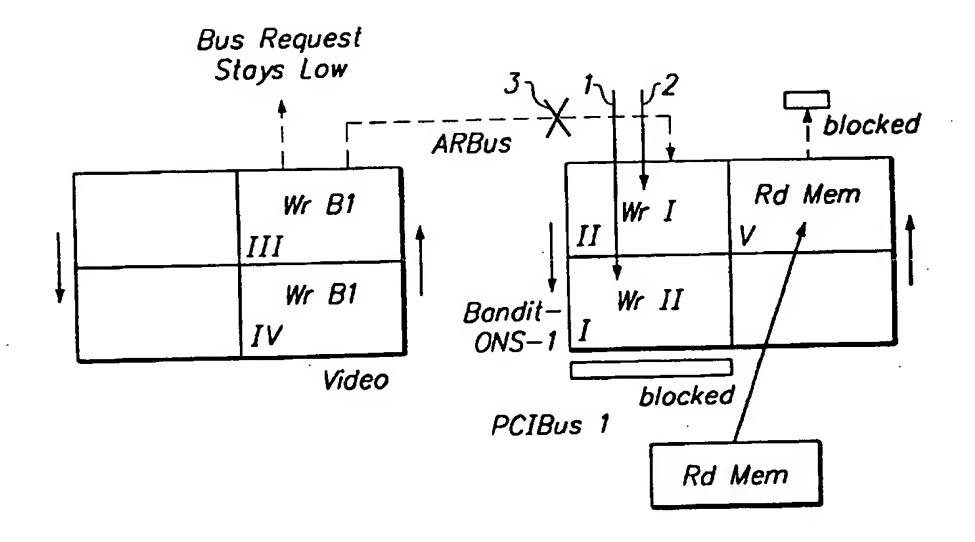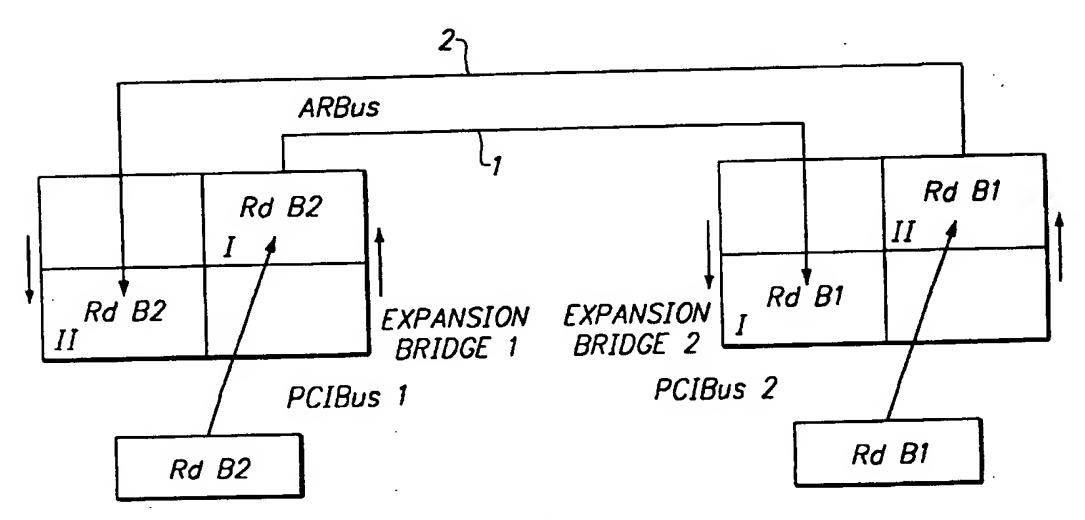Atty. Docket No.: 18602-08098
Sheet 10 of 21

blocked

μP1

μP1 issues ARtry*
μP1 must do Snoop Push
but is blocked by Xfer #2

Memory

2

ARBus

1

3

Wr μP1	Wr Mem (causes Snoop Hit)
II	
Rd μP1 P2P	Wr Mem
I	

EXPANSION BRIDGE 1

PCIBus 1

Rd	Wr

Interlocked PCI2PCI

FIG. 10

μP1

μP2

BG* asserted,
but no TS*
due to
disqualification
by ARtry*

blocked

1

2

3

ARBus

	Wr B2
	III

EXPANSION BRIDGE 1

PCIBus 1

Wr μP2	Wr B1
II	IV
Rd μP1 ISA	Wr B1
I	V

EXPANSION BRIDGE 2

PCIBus 2

Rd Mem ISA

FIG. 11

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
          SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
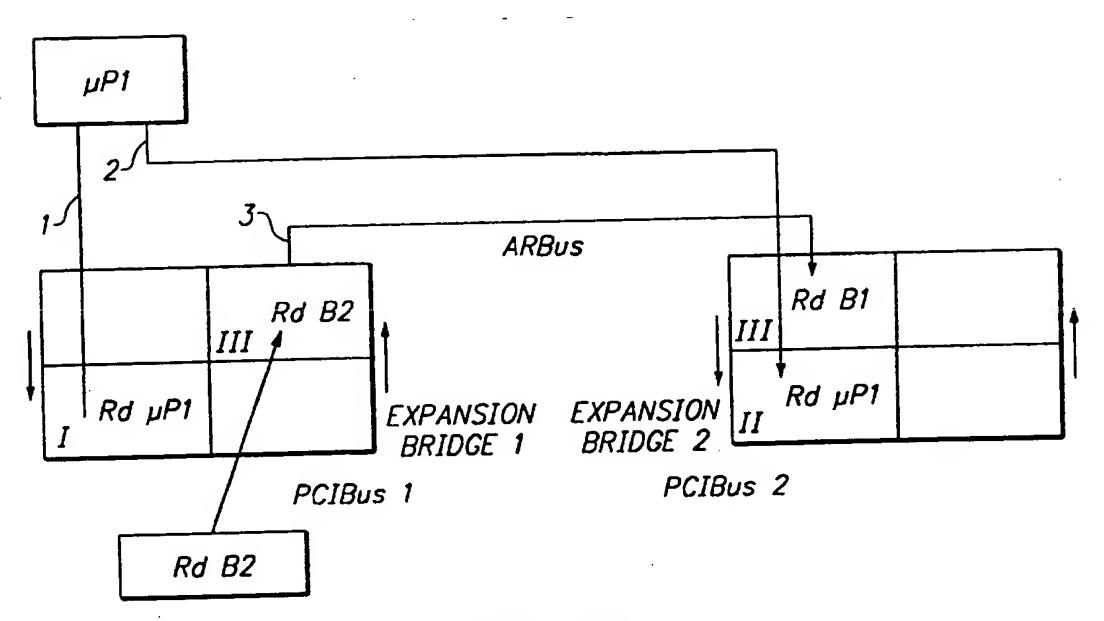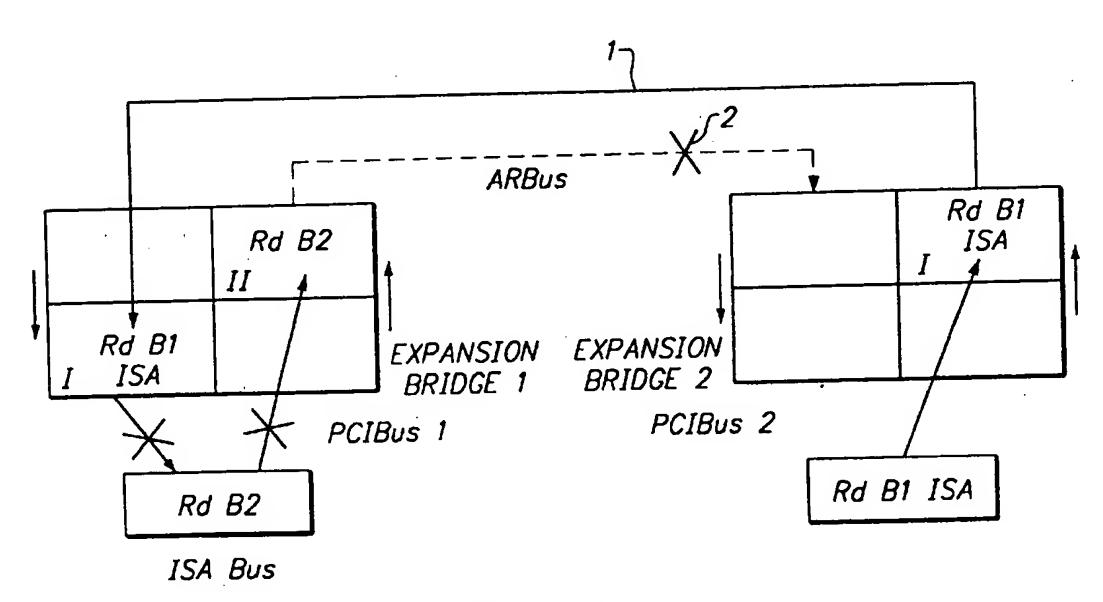Atty. Docket No.:   18602-08098
Sheet 11 of 21

**Bus Request
Stays Low**

3   *1*   *2*

blocked

ARBus

	Wr B1
	III
	Wr B1
	IV

II	Wr I	Rd Mem
		V
	Wr II	
I		

Bandit-
ONS–1

Video

blocked

PCIBus 1

Rd Mem

FIG. 12

2

ARBus

1

	Rd B2	
	I	
Rd B2		
II		

		Rd B1
		II
	Rd B1	
I		

EXPANSION
BRIDGE 1

EXPANSION
BRIDGE 2

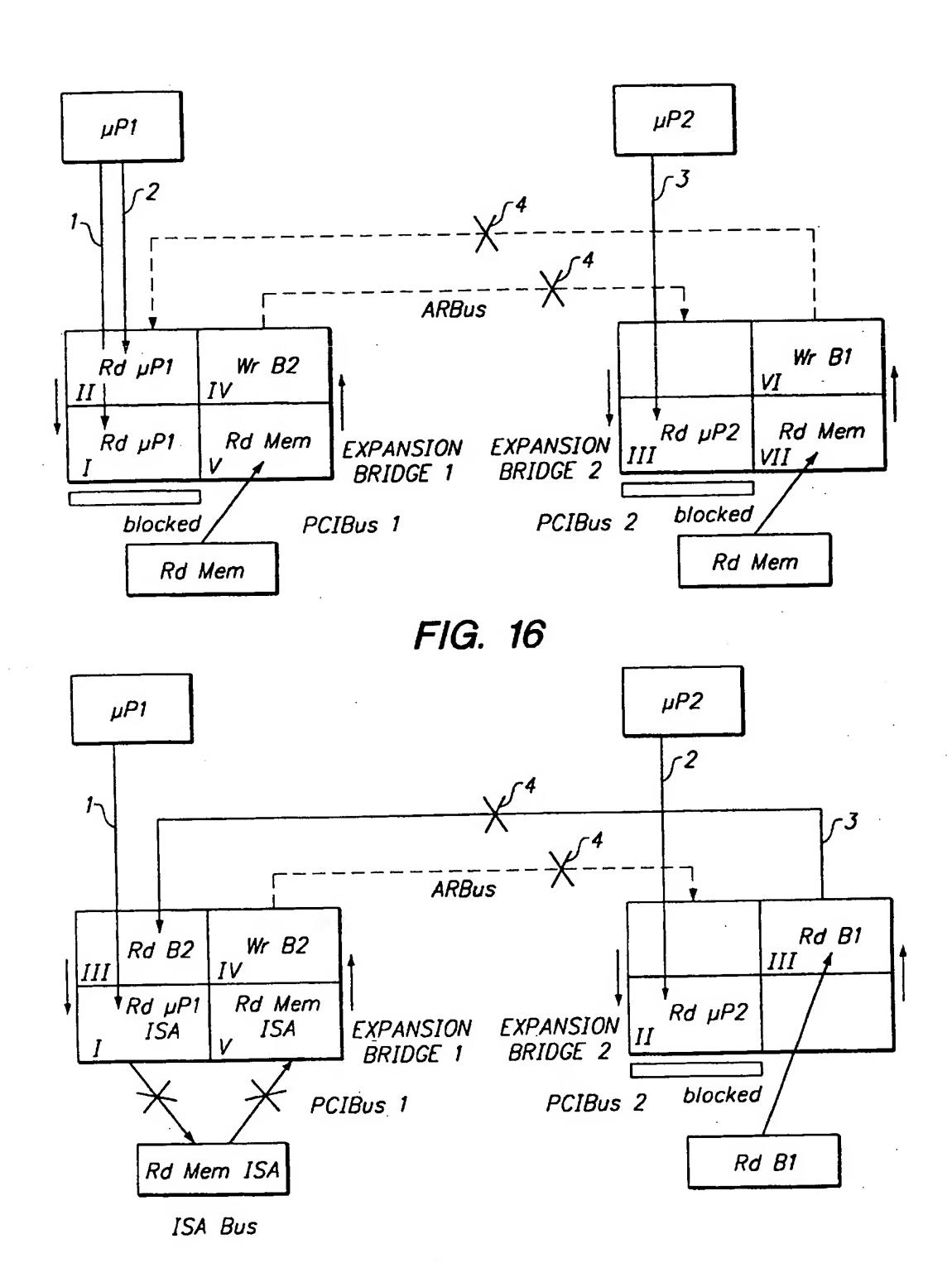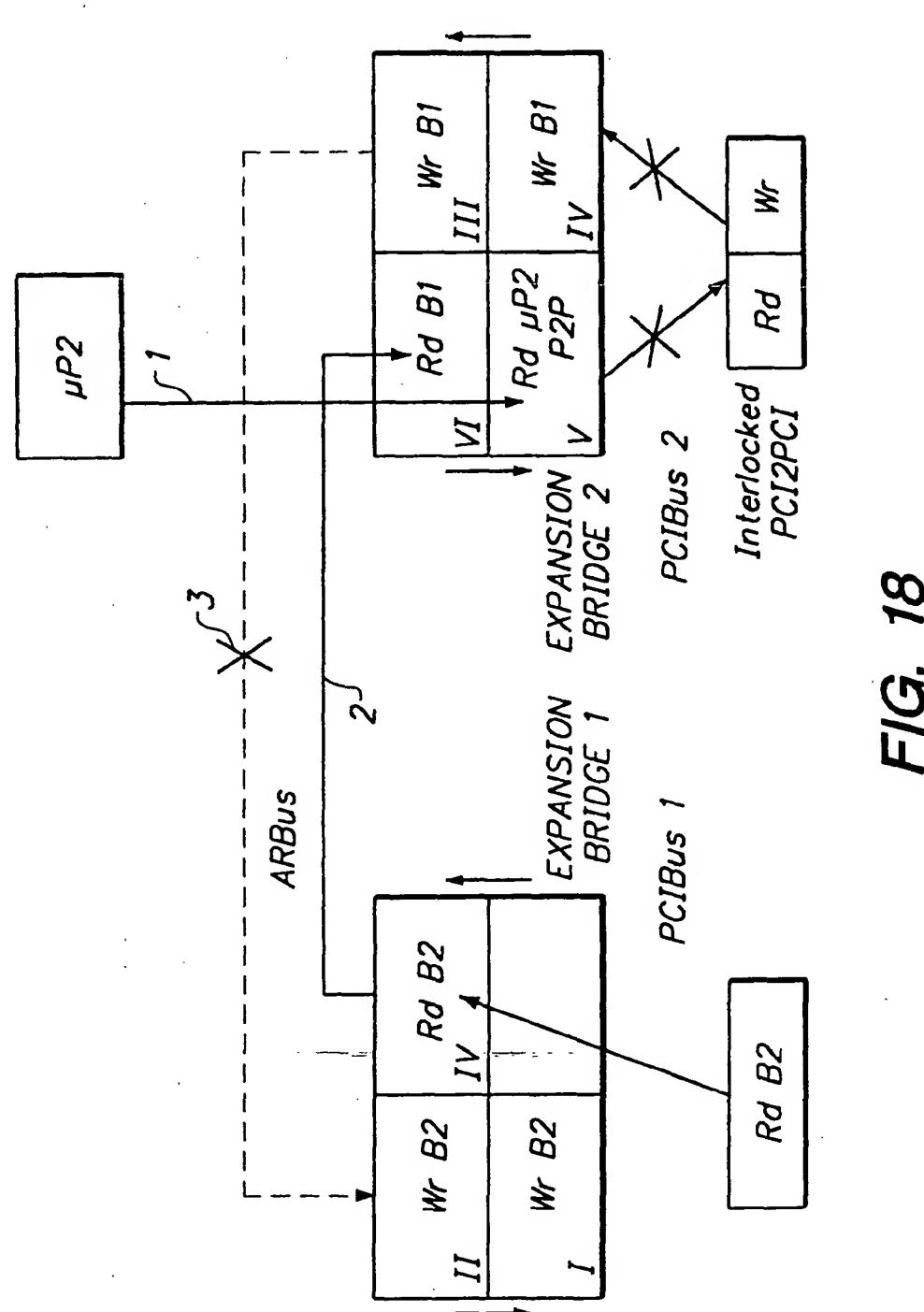PCIBus 1

PCIBus 2

Rd B2

Rd B1

FIG. 13

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 12 of 21

FIG. 14

FIG. 15

Express Mail No. EV342133814US
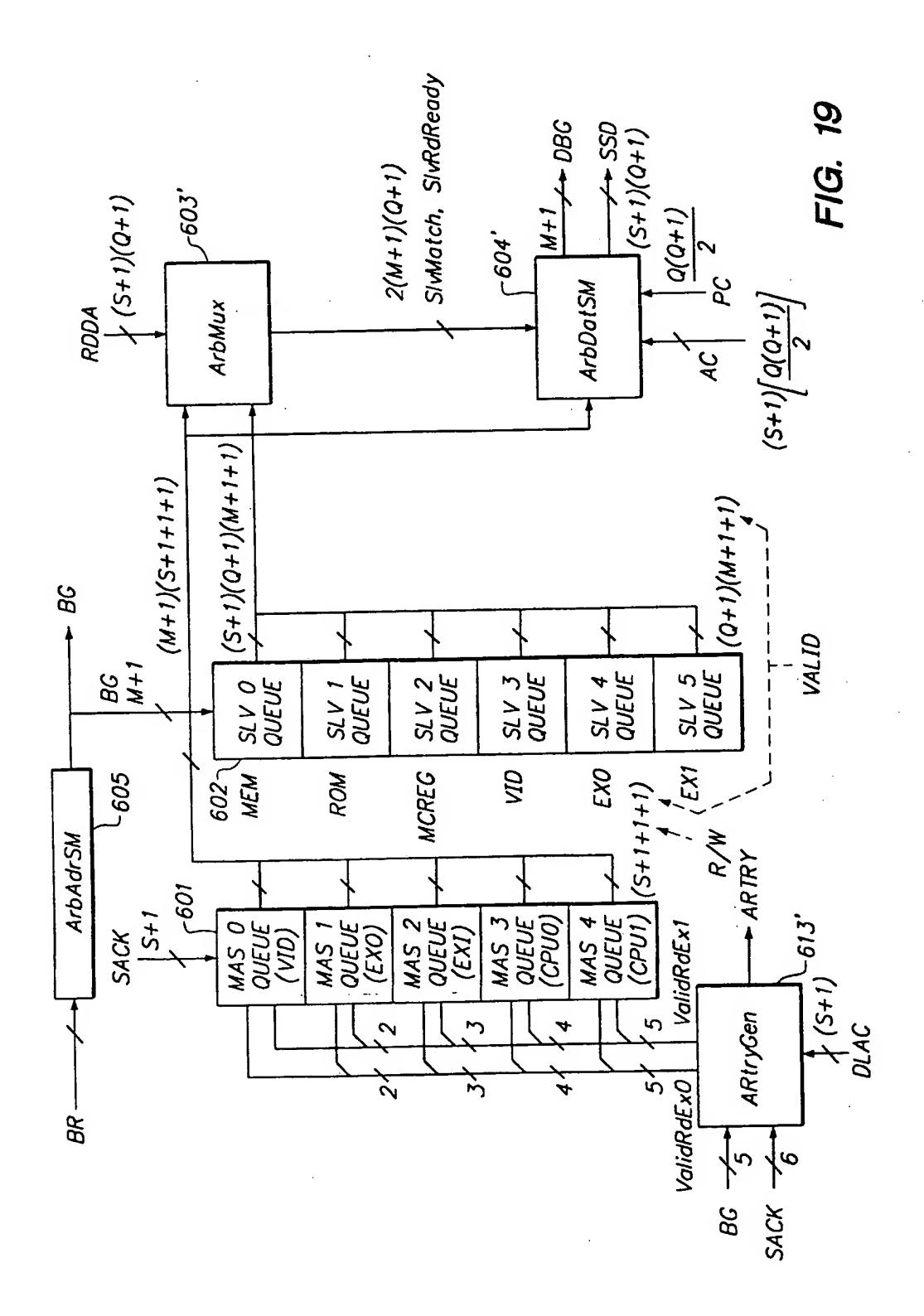Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 13 of 21

FIG. 16

FIG. 17

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
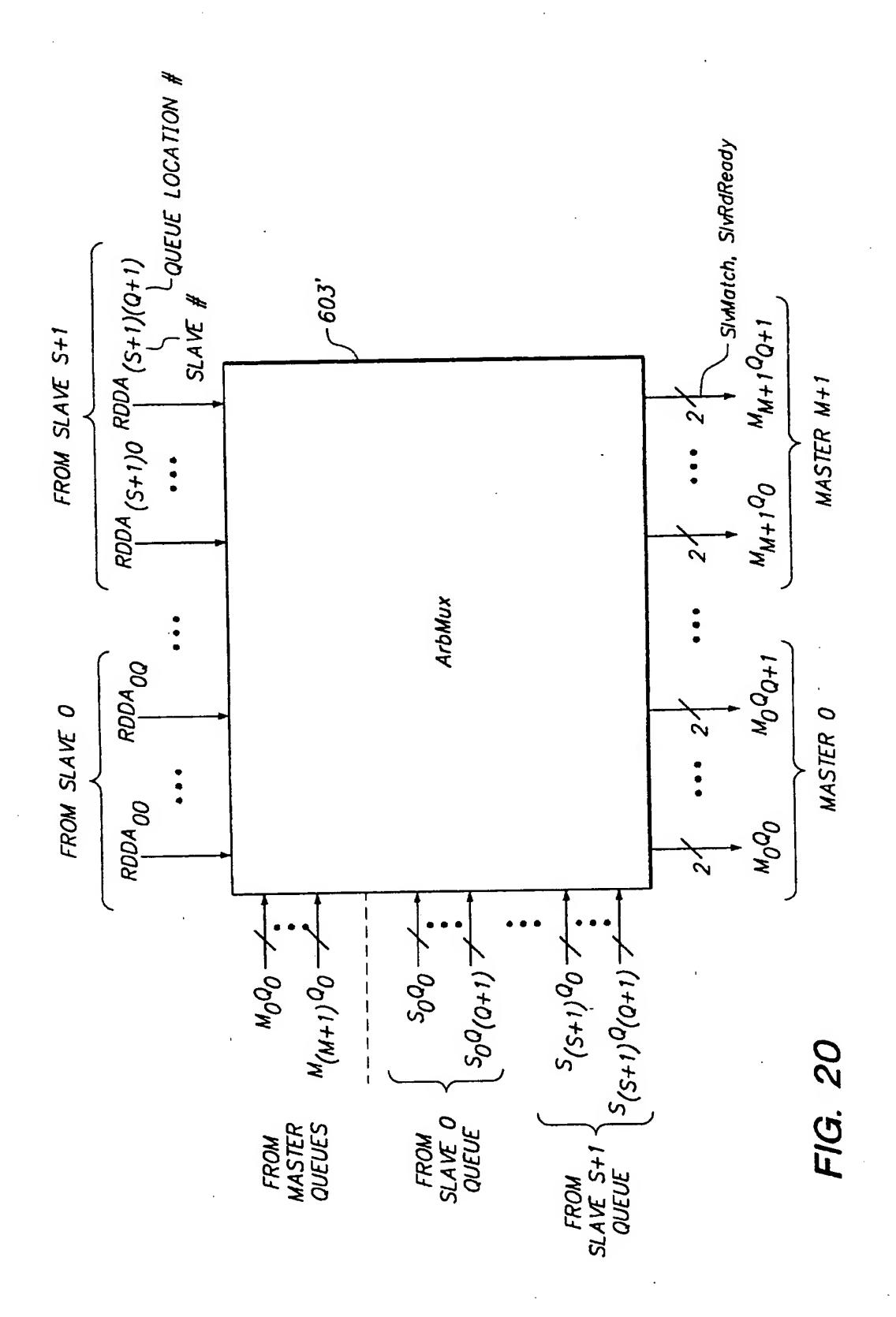Sheet 14 of 21

FIG. 18

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly et al.
Atty. Docket No.: 18602-08098
Sheet 15 of 21

FIG. 19

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
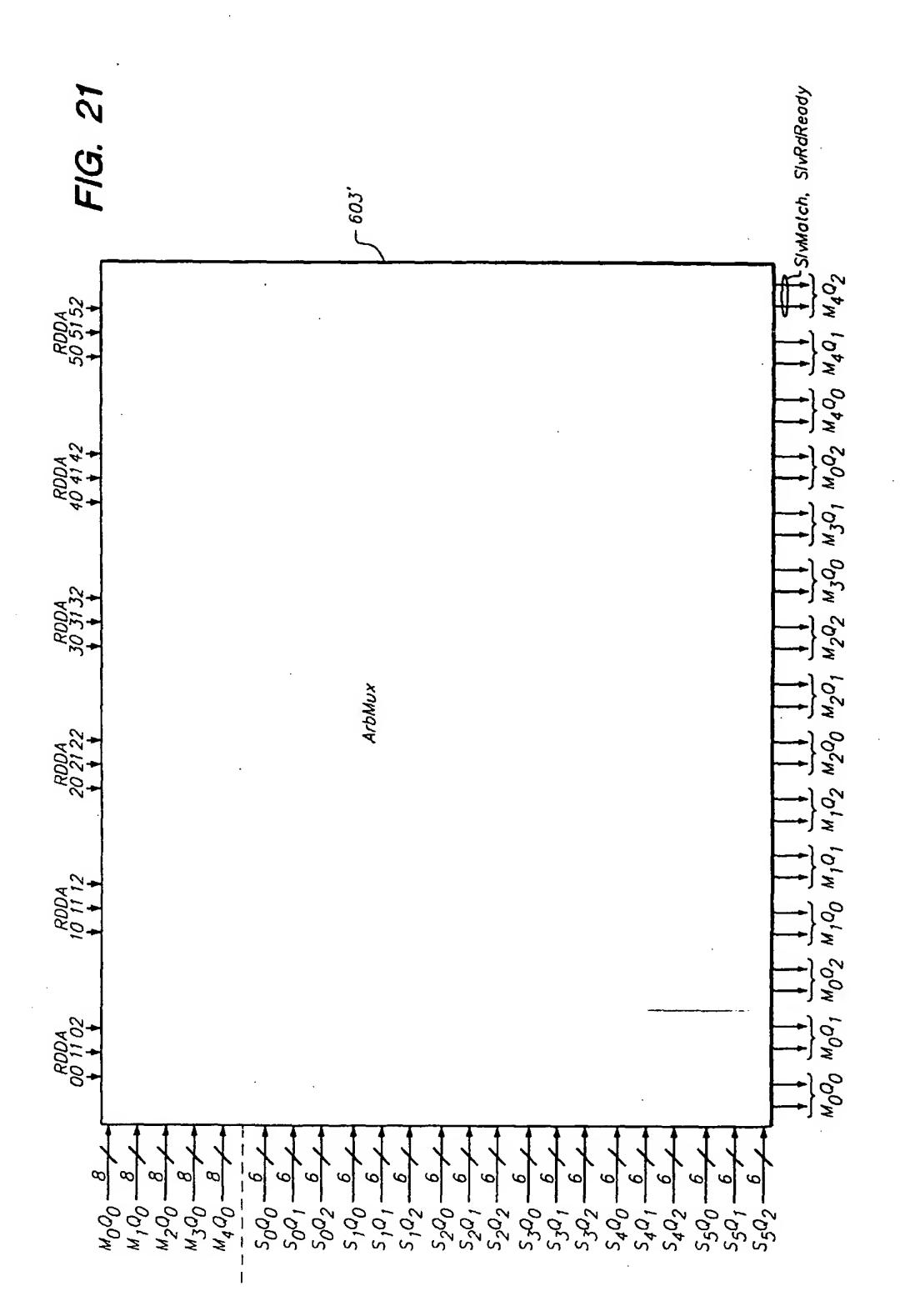Sheet 16 of 21

FIG. 20

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly et al.
Atty. Docket No.: 18602-08098
Sheet 17 of 21

FIG. 21

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
Atty. Docket No.: 18602-08098
Sheet 18 of 21

FIG. 22

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
         SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
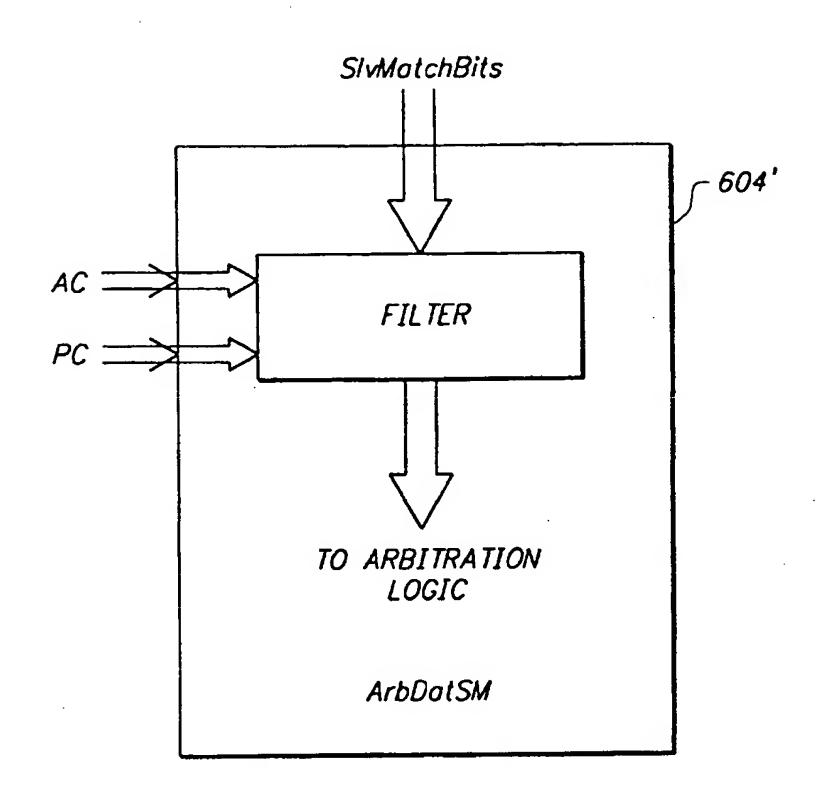Atty. Docket No.: 18602-08098
Sheet 19 of 21

SlvMatchBits

604'

AC

PC

FILTER

TO ARBITRATION
LOGIC

ArbDatSM

FIG. 23

M_0EX0 $M_{(M+1)}^{EX0}$ M_0EX1 $M_{(M+1)}^{EX1}$

• • •   • • •

613'

BG_0

$BG_{(M+1)}$

ARtryGen

ARtry

$SACK_0$

$SACK_{(S+1)}$

• • •

$DLAC_0$ $DLAC_{(S+1)}$

FIG. 25

Express Mail No. EV342133814US
Title: BUS TRANSACTION REORDERING IN A COMPUTER
         SYSTEM HAVING UNORDERED SLAVES
Inventor: James D. Kelly *et al.*
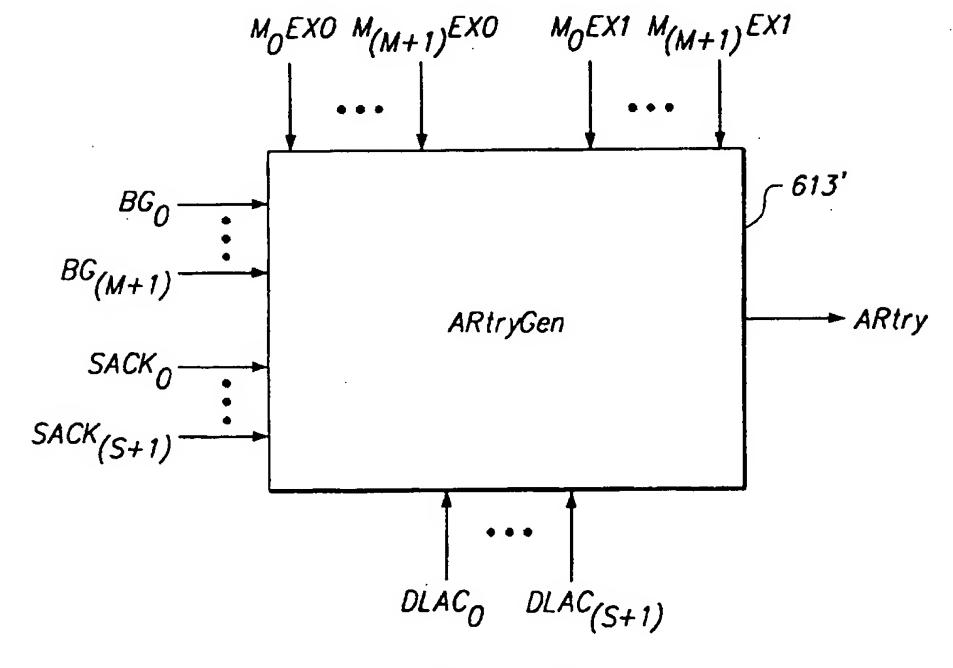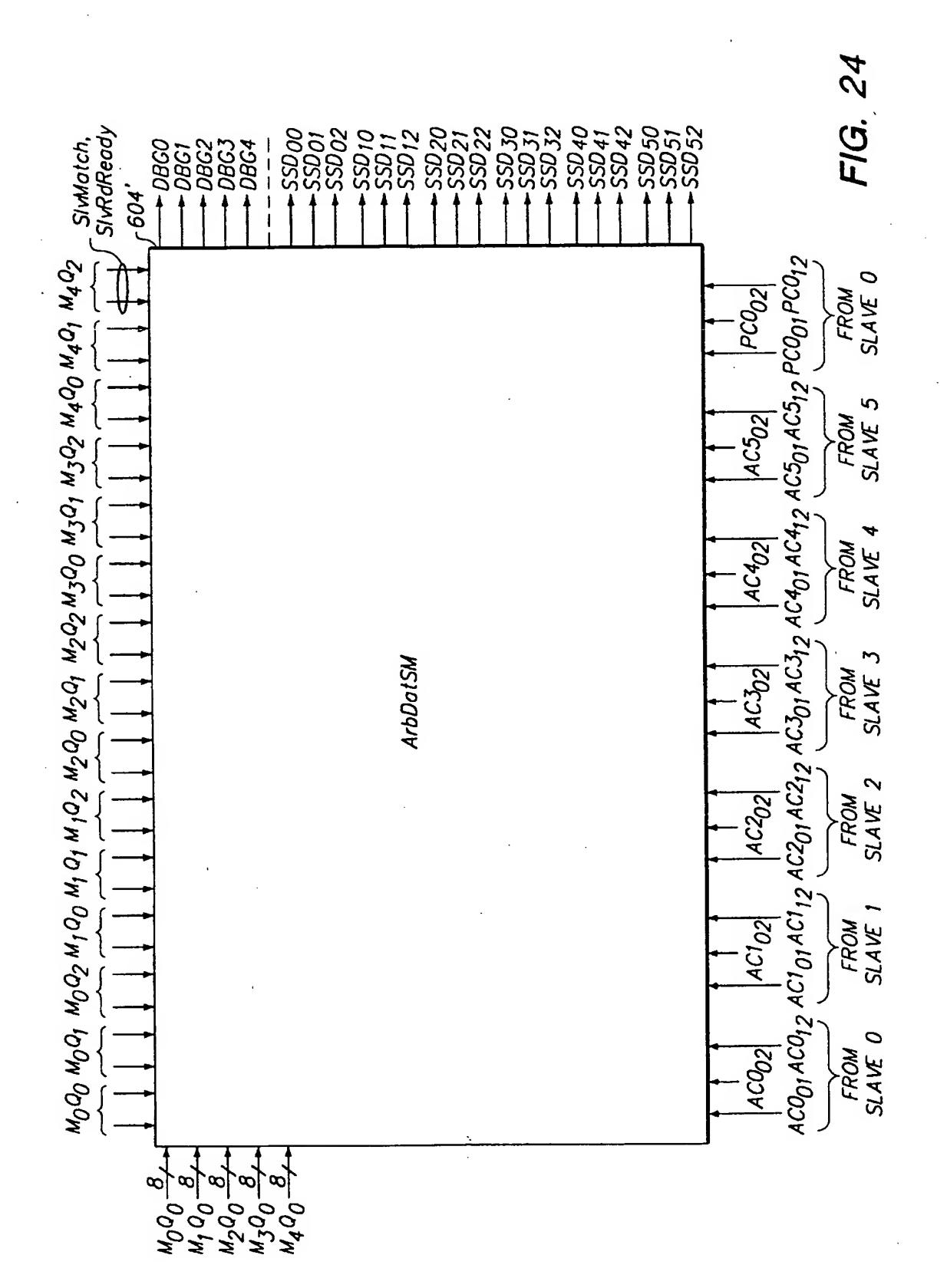Atty. Docket No.: 18602-08098
Sheet 20 of 21

FIG. 24

ArbDatSM

Express Mail No. EV342133814US
Title: Bus Transaction Reordering in a Computer
System Having Unordered Slaves
Inventor: James D. Kelly et al.
Atty. Docket No.: 18602-08098
Sheet 21 of 21

FIG. 26